DE MONTFORT UNIVERSITY LEICESTER

Applying ‘Learning-by-doing’ in undergraduate project management teaching via Engineers Without Borders Student Projects integration

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OUTLINE

- Why Project Management (PM) is important in Engineering?
- Challenges in teaching PM to engineering students
- Course design to tackle the challenge - *Learning and enabling positive social impact: Integration of the Engineering for People Design Challenge*
- Results and discussions
- Conclusions

WHY PM IS IMPORTANT

- Project Management concepts and methods are generally applicable life skills

Source of the figure: http://abhinavpmp.com/2018/11/06/role-of-triple-constraints-in-an-agile-project/

- Engineering companies survive on projects
- Consequences of problematic engineering solutions

CHALLENGES IN TEACHING PM TO ENGINEERING STUDENTS

- Project management is **Dry**!!!
- Concepts and methods are abstract and general
- Perceived as common sense

Project management (PMBOK® Guide) is the application of knowledge, skills, tools, and techniques to project activities to meet the project requirements.

COURSE DESIGN TO TACKLE THE CHALLENGE

Initiative

Allow learners to **learn project management via doing a project**, i.e. **Learning-by-doing** (a teaching method for active learning) (Study.com., 2018) which

"*presents real-life problems to the learners and then guide the learners to solve the problem by providing them with a hands-on activity to learn the solution*".

Challenges of doing this

- **Defining the appropriate scope of a project is difficult.**
- **Capacity issue (Usually only a few students can participate).**

COURSE DESIGN — Framework of teaching: Linking theory to practice

Lecture (200 students)

Theories, methods, project experiences

- Project management context (e.g. what is a project?)
- Scope management
- Quality management
- Schedule management
- Cost management
- Risk management
- ⋮

Placement opportunities

Industry visit

Seminar (≈30-35 students each, i.e. 6 groups)

Group project practice

- Learn the project background and team up
- Identify project scope
- Evaluate design solutions
- Schedule plan
- Estimate design costs
- Risk analysis
- ⋮

Guest lectures from experts & students

- Design and management reports
- Project management knowledge
- Techniques and soft skills for future development

COURSEWORK ASSESSMENT

Assessment

Phase test (40%) — Concepts & methods

- Online test
- Multiple choice questions (30%)
- Open questions (30%)
- Exercises (40%)

Group Project (60%) — Practice

ENGINEERING FOR PEOPLE

DESIGN CHALLENGE

Group Project Report (35%)

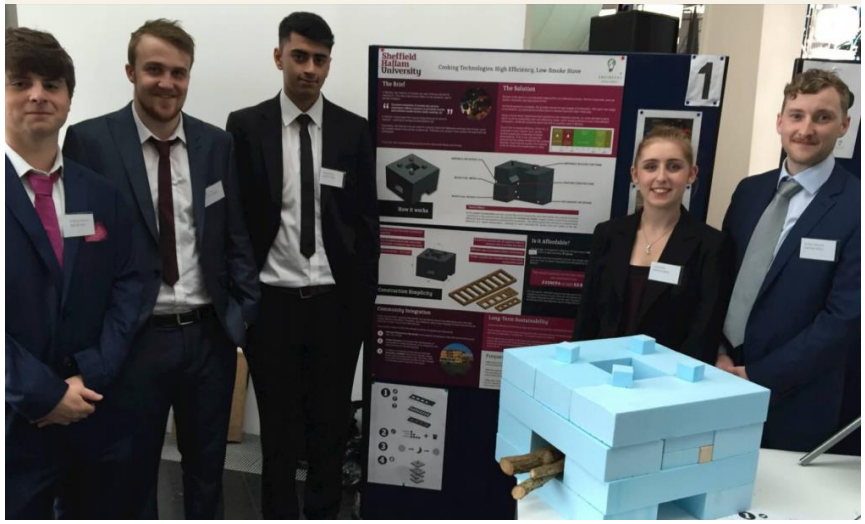
Presentation (25%)

COURSE DESIGN — Group project selection

UK ENGINEERS WITHOUT BORDERS

ENGINEERING FOR PEOPLE

DESIGN CHALLENGE



Source:
https://www.ewb-uk.org/engineering-for-people/

- **A group project**
  (4-5 students in each group)
- **A real-world case study**
  (2019-20: Makers Valley, South Africa
  2018-19: Tamil Nadu, India)
- **Multiple design areas and open questions to choose**
- **Main deliverables**
  Design solution &
  Project management report
- **Duration**
  Throughout the whole module
- **My role**
  Lecture and seminar design
  Project tutor

UK ENGINEERS WITHOUT BORDERS

- Provides opportunities for students to design creative solutions to real world problems through real, sustainable and cross-cultural development projects
- Provides a practical, team-based and innovative approach to assessment inspiring our students to become better engineers and responsible global citizens
- Embedded in the Y2 Project Management module (ENGD2010) for ALL Engineering courses

ENGINEERING FOR PEOPLE DESIGN CHALLENGE
2020/21 DESIGN AREAS (LOBITOS, PERU)

ENGINEERS WITHOUT BORDERS UK

ENERGY

BUILT ENVIRONMENT

TRANSPORT

DIGITAL

WATER

SANITATION

FOOD

WASTE

Engineering for People Design Challenge

UK ENGINEERS WITHOUT BORDERS

ENERGY

7 AFFORDABLE AND CLEAN ENERGY

13 CLIMATE ACTION

11 SUSTAINABLE CITIES AND COMMUNITIES

BUILT ENVIRONMENT

SANITATION

6 CLEAN WATER AND SANITATION

17 PARTNERSHIPS FOR THE GOALS

9 INDUSTRY, INNOVATION AND INFRASTRUCTURE

TRANSPORT

WATER

DIGITAL

FOOD

2 ZERO HUNGER

15 LIFE ON LAND

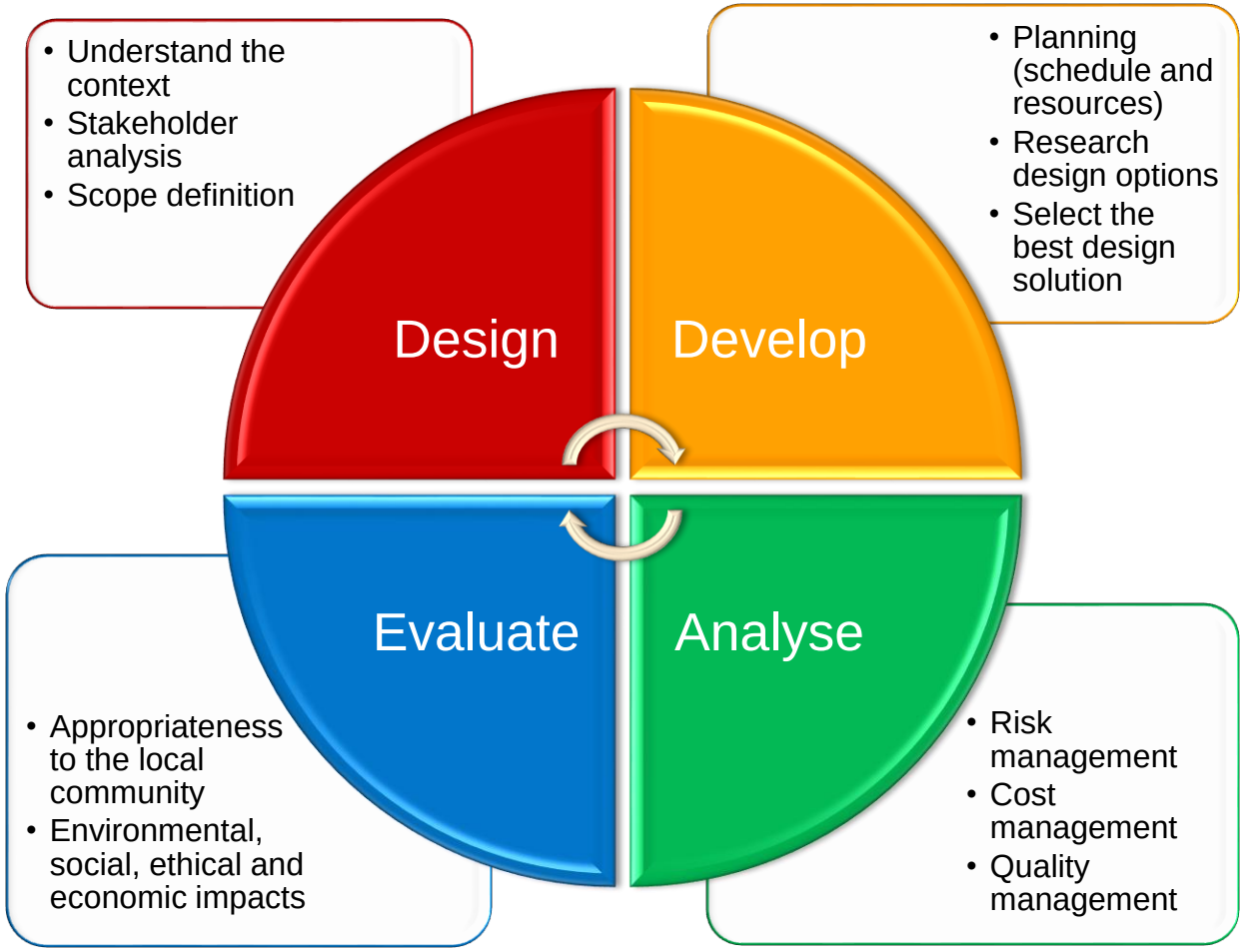
14 LIFE BELOW WATER

12 RESPONSIBLE CONSUMPTION AND PRODUCTION

WASTE

ENGINEERING FOR PEOPLE DESIGN CHALLENGE

UK ENGINEERS WITHOUT BORDERS

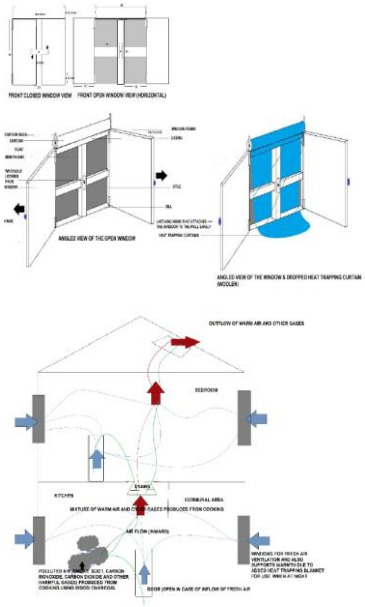


- Problem-based learning
- Using a user-centred design approach
- Evaluate the consequences of design decisions at the local and global level
- Develop their engineering skills
- Develop transferable skills:
  - Teamwork
  - Problem-solving
  - Communication
  - Collaboration
  - Planning and project management

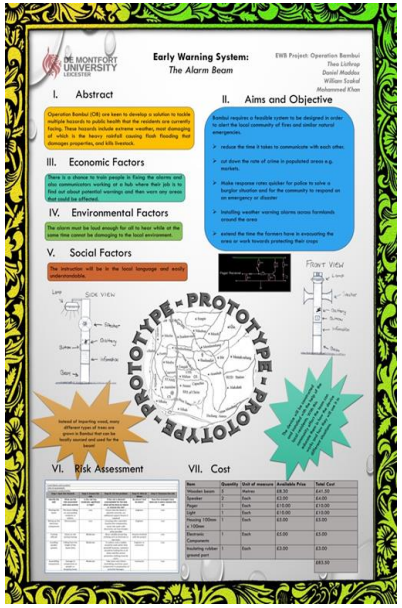
ENGINEERING FOR PEOPLE DESIGN CHALLENGE DMU DESIGN SOLUTIONS

UK ENGINEERS WITHOUT BORDERS

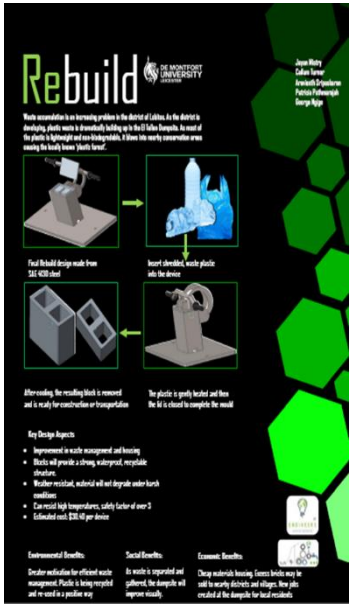
2014/15 (Sandikhola, Nepal)
Two-latched window



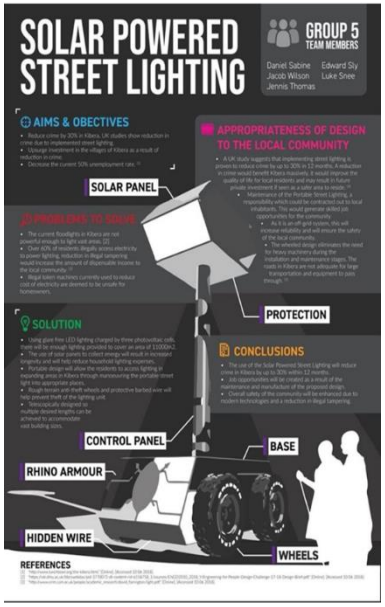
2015/16 (Bambui, Cameroon)
Early warning system



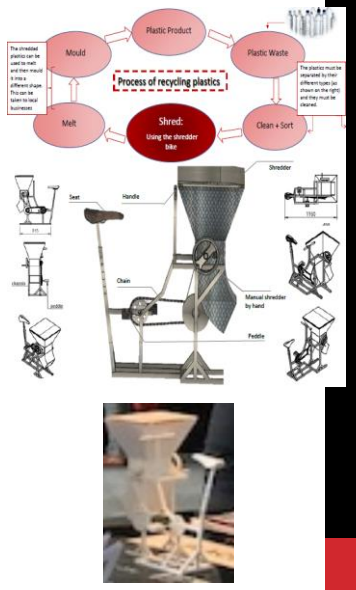
2016/17 (Lobitos, Peru)
Rebuild

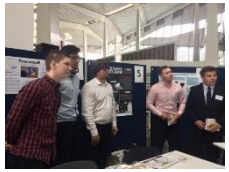


2017/18 (Kibera, Kenya)
Solar powered street lighting



2018/19 (Tamil Nadu, India)
Shredder bike

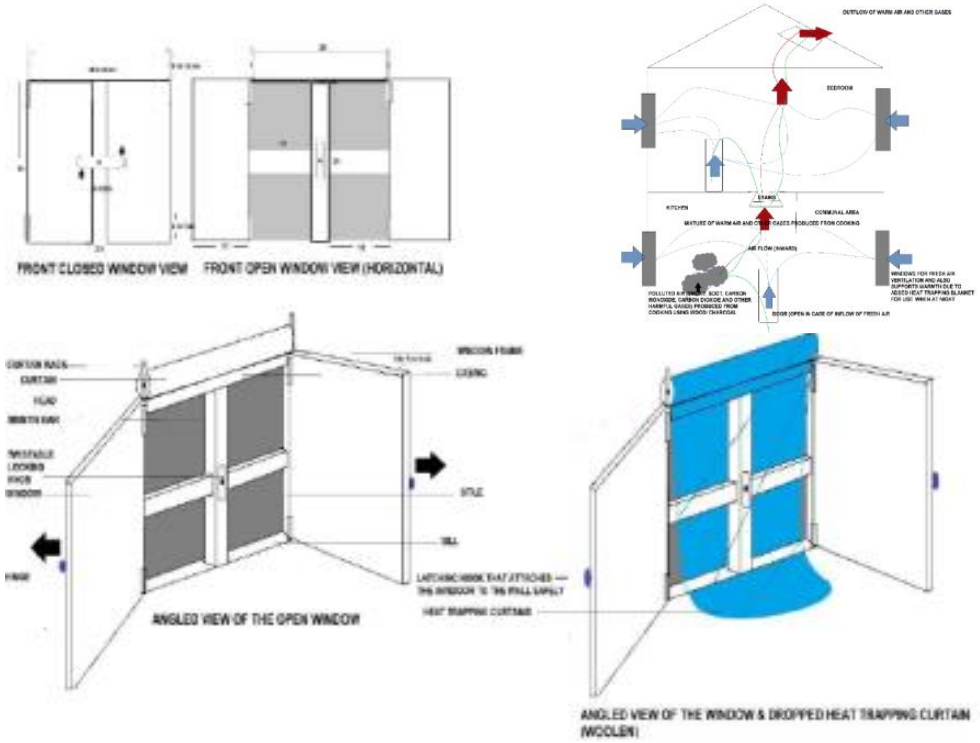




ENGINEERING FOR PEOPLE DESIGN CHALLENGE
DMU DESIGN SOLUTIONS

UK ENGINEERS WITHOUT BORDERS

2014-2015: Two-latched window (Sandikhola, Nepal)



*"… it was nice to have this module **linked to a real project**… Being able to apply yourself as an engineer to any project is important, and **designing creative solutions** that really could **make a difference in somebody's life** is very rewarding and exciting."*

Henry Spencer (2014/15)

COURSE DESIGN — Implementation

Lecture (200 students)

Theories, methods, project experiences

Project management context (e.g. what is a project?)

Scope management

Quality management

Schedule management

Cost management

Risk management

⋮

Define Project Aim

One or two sentences that specifies **WHAT** the project is trying **to achieve (not what to do)**.

- The main problem that the project will solve
- The main negative effects that the project will minimise or eliminate
- The main outcome at the end of the project

Define Project Objectives

Few concise bullets points that specify **HOW** the aim of the project **will be achieved.**

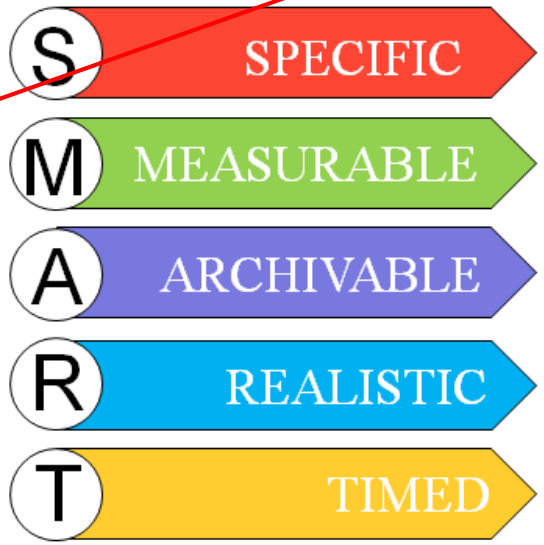
- What factors or negative causes can be addressed by the project?
- How can these factors be addressed?
- To what extent?

What makes a good objective?

EXAMPLES

An objective	An Smarter Objective
Improve awareness of energy and water conservation issues	Educate 1,000 households within Blacktown Council on ways to reduce energy and water usage by 10%

Part of the success criteria



http://www.environment.nsw.gov.au/resources/grants/11846MEgoodob.pdf

TEMPLATES

ENGD2010 – Project Management (2018-19)
Seminars – week 19
Project scope - 1

Group Project overview

Group Project title (or at least selected design option)	
Group Project authors (team members)	

Project aim [specifies WHAT the project is trying to achieve (not what to do)].

- What problem is the project addressing?
- What is the broader impact that the project will contribute to?
- Why is it important to the local community where the project is taking place?
- How does it fit with the local initiatives and targets?

Project aim (1-3 sentences)	

Project objectives [HOW the aim of the project will be achieved]

- What results/outcomes are anticipated from this project?
- How will the objectives contribute to addressing the identified problem?
- What improvement is targeted? How much improvement is required?
- Are there anticipated savings for the project?

Project objectives (3 to 5 bullet points)	

Product Design Requirements

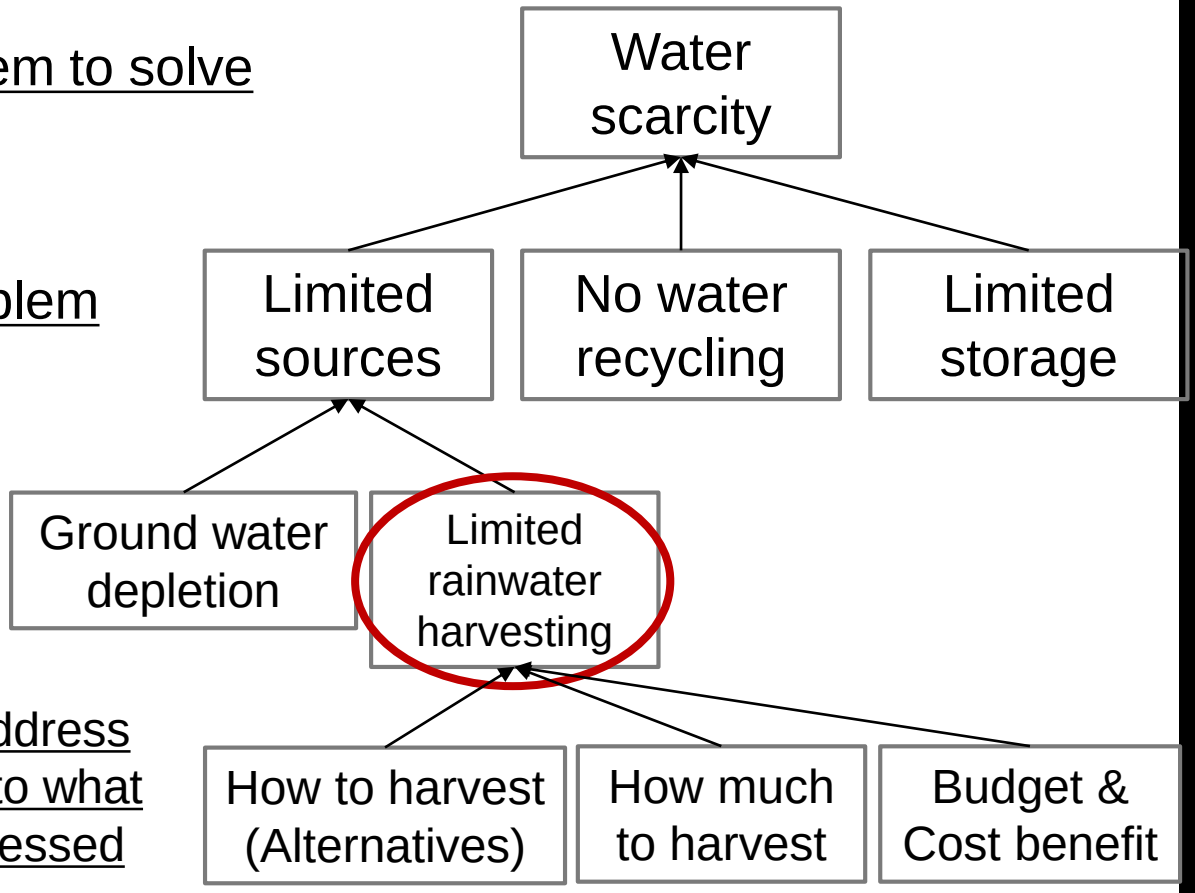
Think about some generic design requirements (first column) that the proposed group design solution may require (regardless of the technology). Complete the table for those requirements applicable to your selected design option.

Design requirements	Brief description of the requirement	Value (success criteria) [units]	Comment
Performance (efficiency or expected output)			
Special features of functionalities			
Capacity (size and weight)			
Operation and maintenance			
Materials OR manufacturing			
Product cost viability			
Other (please			

HOW TO DEVELOP YOUR OBJECTIVES?

You may want to identify:

- The specific problem to solve
- Causes to the problem
- Which cause(s) to address & how to address & to what extent it can be addressed



COURSE DESIGN — Implementation

Lecture (200 students)

Theories, methods, project experiences

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- Risk management
- ⋮

LIFECYCLE COSTING

- Life cycle costing, or whole-life costing, is the process of estimating how much money you will spend on an asset over the course of its useful life. ("*cradle to grave*" or "*womb to tomb*")
- Capital expenditure (**CAPEX**)
- Operating expenditure (**OPEX**)

Theory

Real life examples

Discounted Cash Flow and Net Present Value

Investment: £10,000

Rate: 8%

Methodology

Year	Cash flow	PV (A)	PV (A)
0	-£10,000	$-£10,000/(1+0.08)^0$ =	-£10,000
1	£2,000	$£2,000/(1+0.08)^1$ =	£1,852
2	£4,000	$£4,000/(1+0.08)^2$ =	£3,429
3	£12,000	$£12,000/(1+0.08)^3$ =	£9,529
NPV = Σ (PV) =			£4,809

Year	PV (B)	PV (C)
0	-£10,000	-£10,000
1	£9,259	£5,556
2	£2,572	£3,429
3	£2,381	£3,969
NPV	£4,213	£2,954

PROBLEM SOLVING AND KNOW STANDARD OF GOOD WORK

Example:

In Kenya, availability of shoes is low due to lack of resources. What is your solution?

Step 1. Study on the context (PESTLE)

- What kind of shoes people there are looking for and why?
- Why it is a problem for local people?
- What are the common ways to get shoes and why it is currently not working in Kenya?

PROBLEM SOLVING AND KNOW STANDARD OF GOOD WORK

Step 2. Define the problem and the design criteria

- What is the key cause(s) of the problem?
- The specific criteria of the shoes demanded. E.g. The acceptable price, material, functions? The local standards. (Design requirements)

THE PROCESS OF IDENTIFYING GOOD DESIGN SOLUTIONS

Step 3. Explore all available solutions

Please note:

- Need to do literature review rather than only brainstorming.
- If a method is good but too expensive, it is not a real solution.
- Need to adapt it into the local conditions, e.g….

An example of scaffolding

PROBLEM SOLVING AND KNOW STANDARD OF GOOD WORK

Step 4. Justify your recommendation and explain how it works

Please note:

The idea and efficiency should be self-explanatory.

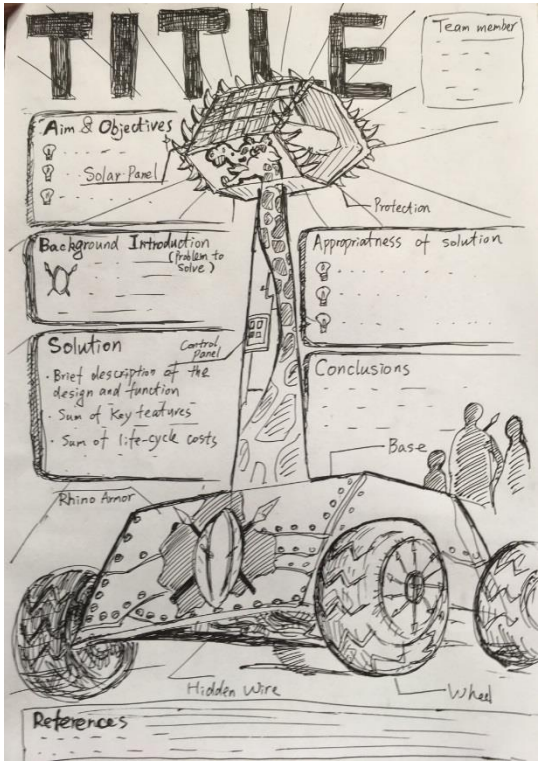
If you need many words to explain, it is likely not a convincing solution.

PROBLEM SOLVING AND KNOW STANDARD OF GOOD WORK

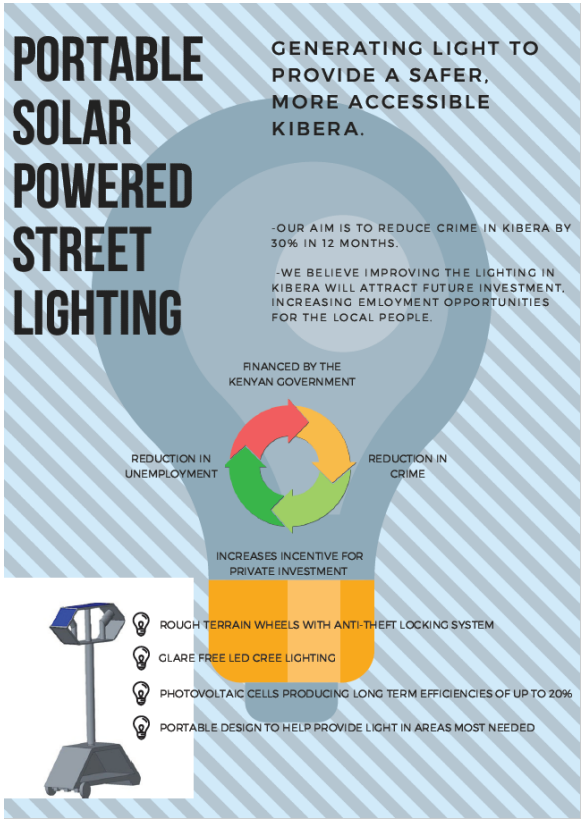
The current solution to the example's problem

https://m.youtube.com/watch?v=z8eY-LR494U

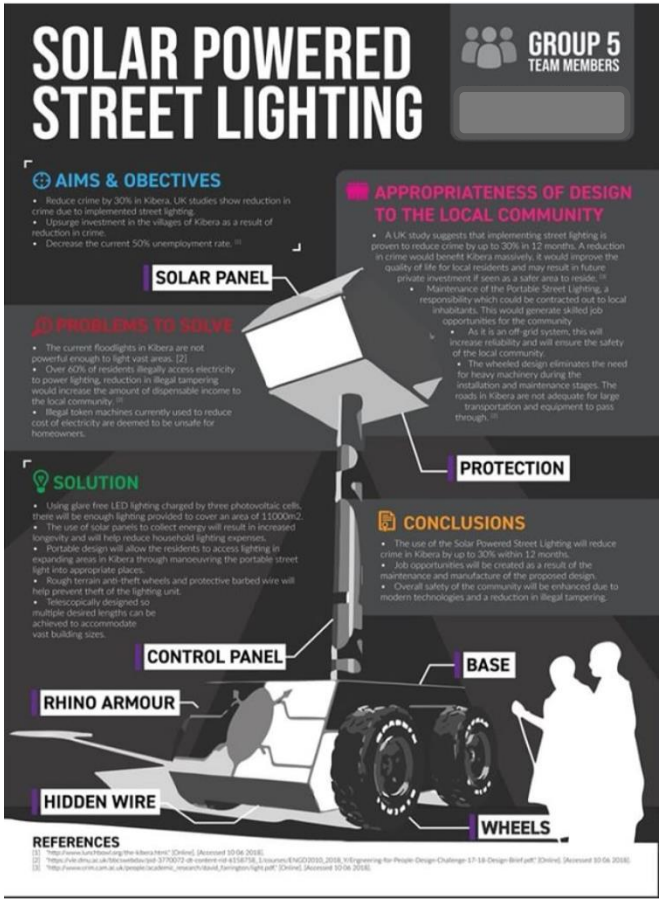
Lecturers' sample design



Learners' original design



Learners' final design

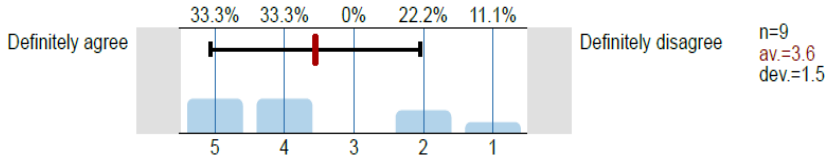


RESULTS

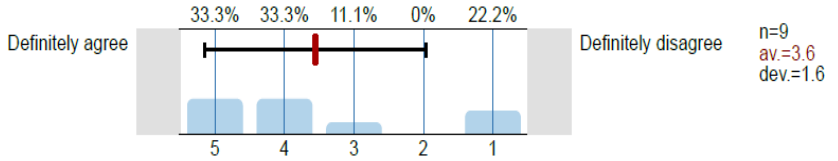
The 2019/20 module survey result shows a score of 3.8/5, which is the average of 23 evaluations (range from 3.3 to 4.6) categorized into seven categories

2. Learning Outcomes

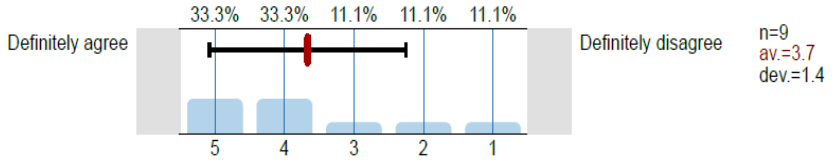
2.1) The module was academically stimulating.



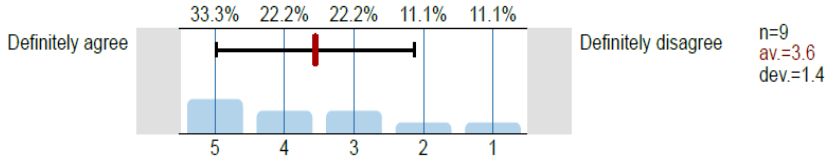
2.2) The module provided me with opportunities to apply my learning and do my best work.



2.3) It was clear why I should attend and contribute to classes / seminars / lectures / labs / practicals.



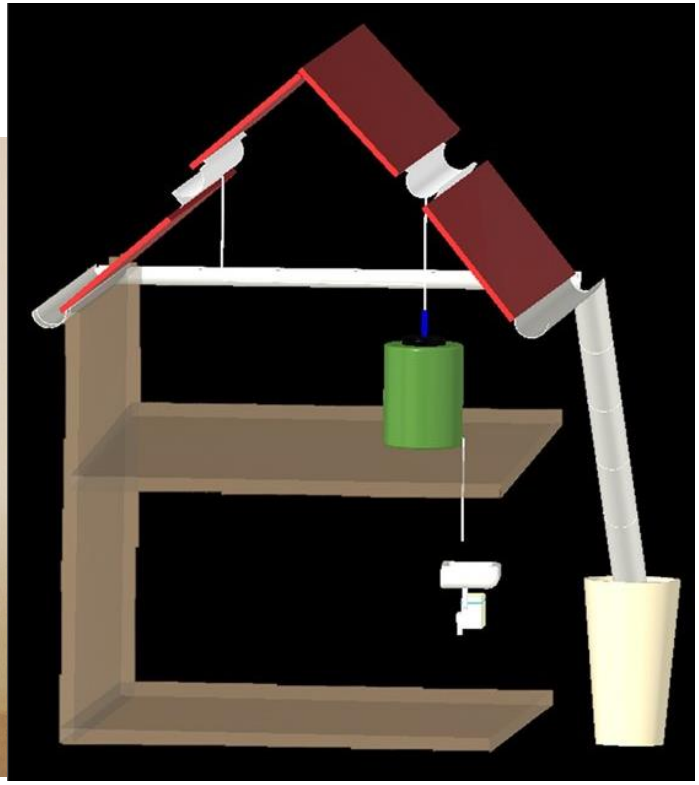
2.4) I felt engaged with the content and aims of the module.



One recent outcome: ‘Engineering students secure top prize out of UK universities for sustainable water system design

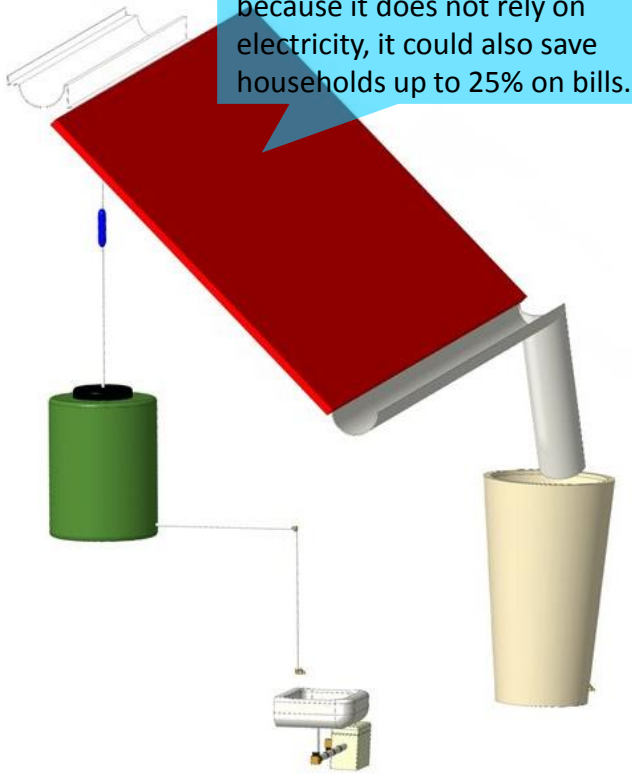
https://www.dmu.ac.uk/about-dmu/news/2020/july/engineering-students-secure-top-prize-out-of-uk-universities-for-sustainable-water-system-design.aspx

Pawel Szczygiel was the team leader on the project



Engineering students designed a sustainable water gathering system

The system would reduce tap water use by 40 litres a day and because it does not rely on electricity, it could also save households up to 25% on bills.



The system reuses rainwater by collecting it through two gutters

CONCLUSIONS

- The developed **Project-based Action Learning (PAL)** framework engaged learners and created mutual benefits in terms of developing theoretical understanding and practical problem-solving ability.

- Applying the award-winning Engineering for People Design Challenge project motivated learners to deliver high quality work, e.g. one group is awarded the runners up prize in the E4PD Grand Final 2020.

- The project also raises the awareness of UN SDG goals in sustainable engineering, and presented connections between engineering and people and how the solutions link to society, e.g. technology serving people to improve their lives.

THANKS VERY MUCH FOR YOUR ATTENTION !!! ☺